GUIDELINES FOR EPN DATA CENTRES & EPN BROADCASTERS

EPN Central Bureau
C. Bruyninx, epncb@oma.be

Updates:

April 25, 2023	Full replacement of OLG by BEV in the text
	Added EPN products to the data flow
	Added specifications on the real-time product format
	Added specifications to trace operations on RINEX data at data centres
	Correction of Fig.1 and Fig. 2
April 11, 2017	Regional data centre OLG is replaced by new regional data centre BEV in data flow figures
March 17, 2015	Added guidelines for EPN regional and local / national broadcasters
June 13, 2012	Modified links due to the EPN CB web site restructuring
Oct. 5, 2005	Introduced reviewed EPN data flow
March 10, 2003	Added guidelines for concatenation of hourly files into daily files
Nov. 24, 2000	Added “The LDC cannot significantly delay the data upload to the RDC"

Very strict rules are inconsistent with the voluntary nature of the EUREF Permanent Network (EPN). However, Data Centres and Broadcasters participating to the EPN must agree to adhere to certain standards and conventions, which ensure the quality of the EPN. This document gives guidelines for new and operating EPN Data Centres and Broadcasters.

All electronic messages, unless otherwise specified, should be sent to the EPN CB at epncb@oma.be.

Contents

1 Organization of the EPN Data Flow

1.1 Network Components

En route to Analysis Centres and other users, the tracking data collected by permanent GNSS receivers flow through the following components of the EPN network:

- **Tracking Station (TS)**: Sets up and operates the permanent GNSS tracking receivers and antennae on suitable geodetic markers.
- **Operational Centre (OC)**: Performs data validation, conversion of raw data to the Receiver Independent Exchange Format (RINEX), data compression, and data upload to the Data Centres through the Internet. For some sites, the OC is identical with the institution responsible for the respective site (i.e., the OC is identical with the TS).
- **Local Data Centre (LDC)**: Collects the data of all stations in a local network and distributes them to the users (local and EUREF). For many of the local networks, the LDC will be identical with the OC. The LDC will forward the data (or a selection) of the local sites to the Regional Data Centre. If there is no LDC available for a particular station, then its data will flow directly from the OC to the Regional Data Centres.
- **Regional Data Centre (RDC)**: It collects the data from all EPN stations. The RDC makes the data and products available to the local, regional and IGS users.
- **High-Rate Data Centre (HRDC**): It collects 1 Hz data from all EPN stations (either directly from the stations (recommended) or from real-time streams), archives them in 15-min files in RINEX format and makes them available to the users.
- **Historical Data Centre (HDC)**: It provides an open access historical archive of all daily RINEX EPN data, including data from EPN stations prior to their installation in the EPN. RINEX headers are corrected to be consistent with the station metadata (site log).
- **Local Broadcaster (LB):** It receives the real-time data streams from the stations in a local network and disseminates them, without changing them, on request to clients. Clients may be users, monitoring tools, Regional Broadcasters, Data Centres, or Analysis Centres.
- **Regional Broadcaster (RB):** It receives all the EPN real-time data and product streams and disseminates them, without changing them, on request to clients. Clients may be users, monitoring tools, other broadcasters, Data Centres, or Analysis Centres.
- **Analysis Center (AC):** The EPN operational ACs are processing the EPN data and upload the results to the RDCs.
- **Analysis Center Coordinator (ACC):** The ACC downloads the AC individual results, combines them and uploads the combination result to the RDCs.
- **Troposphere Coordinator (TC):** The TC downloads the AC individual troposphere results, combines them and uploads the troposphere combination result to the RDCs.

1.2 Schematic Overview for EPN Data Centre

To guarantee the availability of the EPN data at the regional level, two RDCs are in operation. Each RDC makes available the data of all EPN stations.

In the following, we will use the wording “Data Centre” (DC) for both the RDC and LDC.

All EPN data must be available at the two regional data centers (RDC): BKG (Bundesamt für Kartographie und Geodäsie, Germany) and BEV (Bundesamt für Eich- und Vermessungswesen, Austria). Under normal conditions, BKG routinely uploads the relevant EPN data to the IGS.

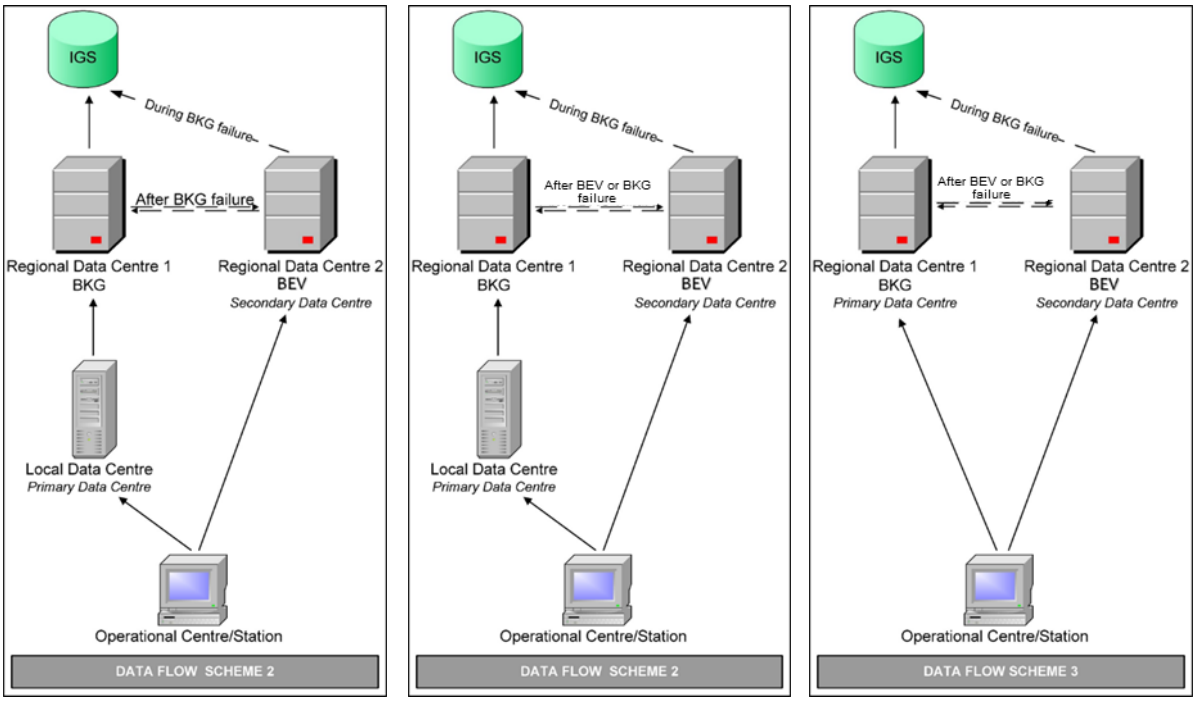

Figure 1: Standard data flow schemes within the EPN.

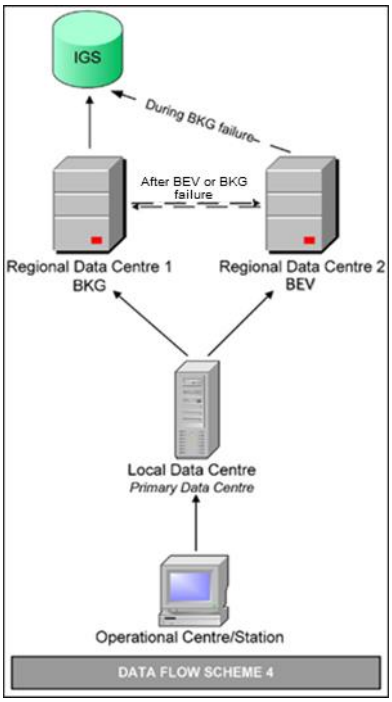

Figure 2: EPN data flow scheme, used only in case the standard data flow schemes cannot be implemented.

To achieve the highest reliability, it is imperative that the station uses two independent data flow paths to upload the EPN data to the two RDCs. The three possible standard data flow schemes are given in Figure 1. Figure 1 applies similarly for the products uploaded by the ACs, the ACC and the TC. The

majority of the EPN stations/OCs use scheme 3 and directly provide their data to the two RDC. If however a station chooses to use scheme 1 or 2, then it has to make sure that the LDC to which it is sending its data is effectively uploading the data routinely to the agreed RDC.
Exceptionally, if none of the schemes in Figure 1 can be applied, the scheme given in Figure 2 can be used. In this scheme, the station/OC submits its data only to one Data Centre, noted as the 'Primary Data Center' in the site log. In case of a failure of this LDC, the data flow will be interrupted. For this reason, this last scheme is not considered as optimal.

2 Requirements for Local Data Centres

The Local Data Centres give access to the data of a local tracking network, distribute it to the users (local and EUREF) and upload the data to one of the RDC (schemes 1 and 2 in Figure 1).

2.1 Data Access

Access to the data is still possible through Internet's anonymous ftp. It is presently the most effective and easy-to-use access method for large data quantities, and especially for automated data download. However, due to security reasons, the usage of ftp might be no longer available in the DCs on a short term. It is recommended to use encrypted protocols such as https or sftp as alternatives and safer ways of download, e.g. via lftp or wget commands (see https://igs.bkg.bund.de/access for examples).

2.2 Available Information

It is recommended that the LDC makes at least the following information available:

- **Daily tracking data** (RINEX files, in the Hatanaka compressed format) including results of quality checks.
  It is recommended to organize at least the tracking data in a hierarchical directory structure. From the user's point of view, it is usually preferable to combine all the data of one day (or one week) into one directory than to have station-dependent directories. Examples of directory organizations can be found in the EPN Data Centre description files
  https://epncb.oma.be/ftp/center/data/
- **Daily updated data holding information** (i.e. a machine-readable summary of the available tracking data). An example of such a Data Holding file can be found at
  - https://epncb.oma.be/ftp/data/holding/daily/CHECK_IMPORT.ROB

  The daily updated data holding file will be the basis for the daily generation of a data holding file for the complete EPN (example: https://epncb.oma.be/ftp/data/holding/daily/glob2022.syn).

If the LDC supports hourly data files, then in addition the following information should be made available:

- **Hourly tracking data** (RINEX files, in the Hatanaka compressed format) including results of quality checks.
- **Hourly updated data holding information** (i.e. a machine-readable summary of the available tracking data). An example of such a Data Holding file can be found at
  - https://epncb.oma.be/ftp/data/holding/hourly/CHECK_HOURLY.ROB

  The program to generate data holding files is available on request from the EPN Central Bureau.

2.3 Concatenation of hourly data files

In general, the stations/OCs are responsible for creating daily files. If the station/OC is not able to upload daily files in addition to hourly files, it is recommended that the LDC implement the necessary procedures to concatenate the hourly data into daily data. The decision to discontinue daily transfer and

switch to only hourly transfer is initiated by the OC, which sends this request to the LDC. The LDC should handle as follows:

- If it wants to accept the request from the OC, send a confirmation by e-mail back to the OC and inform the EPN CB.
- Prepare an automatic procedure, which can concatenate hourly RINEX files to a daily RINEX file. This procedure should run at least once a day and should start as soon as possible after receipt of the last expected hourly file.
- Repeat concatenation in the case hourly files arrive late or are resubmitted
- After three days only daily files should be accepted
- The concatenated daily file should be sent as soon as possible to the RDC.
- The header of the concatenated daily file should contain a comment line containing information about the agency that did the concatenation, the program used to do the concatenation, and the date.

2.4 Data Transfer to the Regional Data Centre

To have all EPN data available at both RDCs, the LDC have the responsibility of uploading the station data to the RDC to which the station/OC is not uploading its data (schemes 1 and 2). This concerns both hourly and daily data.
It is the responsibility of the LDC not to significantly delay the upload to the RDC. The upload commands depend on the most recent and secure encrypted upload mechanism implemented at the RDCs. More details on communication from and to each of the EPN Data Centres can be obtained from ftp://ftp.epncb.oma.be/pub/center/data. General information about the data format is available in "Guidelines for EPN Stations and Operational Centres" at https://epncb.oma.be/_documentation/guidelines/guidelines_station_operationalcentre.pdf.

2.5 Documentation

The Data Centre Information Form (blank forms and examples https://epncb.oma.be/ftp/center/data can be found at the EPN CB web site) needs to be completed and sent to the EPN Central Bureau. In addition, the Data Centre Form needs to be updated for:

- Changes in the access to the data centre, such as: changes in the directory structure, switches to a different server (to be announced some days in advance through EUREF mail)
- Changes related to Data Centre responsible

and sent to the EPN CB.

3 Requirements for Regional Data Centres

Regional Data Centres must adhere to the same guidelines as the LDC. However, in addition to the LDC, the RDC have the responsibility of uploading the relevant EPN data to the IGS. Under normal conditions, this is the task of the BKG RDC. In case of failure of the BKG RDC, BEV will take over the upload to the IGS.

3.1 High-Rate Data Centre

Besides daily and hourly data, the RDC may host also an HRDC. The 1 Hz, 15-minutes RINEX files are uploaded directly from the station to the HRDC. If stations are not able to generate the high-rate files by themselves, the HRDC is generating the RINEX files from real-time streams and name this RINEX files to clearly reflect they are originating from a real-time stream.
The high-rate files are separately made available in hourly subdirectories, however, for storage reasons, after e.g., six months, the high-rate files may be merged and archived in one tar file per day and the corresponding subdirectory is removed.

4 Requirements for Regional and Historical Data Centres

4.1 File Provenance

As stated by Resolution no. 2 of the EUREF symposium in Ljubljana (http://www.euref.eu/symposia/2021Online-from-Ljubljana/06-02-Resolutions-p-EUREF2021.pdf), EUREF aims at evolving towards applying Findable, Accessible, Interoperable, and Reusable (FAIR) data management. In that frame, it is important that the RDC/HDC provide publicly available information on

- The origin of the data available at the RDC/HDC (e.g., directly received from a station, retrieved from another Data Centre, …);
- The operations performed on the data available at the RDC/HDC (e.g., programs run on the data, RINEX header corrections);
- The filters the RDC/HDC use to withhold publication of the data.

5 Requirements for Local and Regional Broadcasters

As described in section 1.1, there are two different broadcasters available in the EPN, **Local Broadcasters (LBs),** receiving the real-time data streams from the stations in a local network and disseminating them, and **Regional Broadcasters (RBs)**, receiving all the EPN real-time data and product streams and disseminating them, without changing them, on request to clients. As long as it is not indicated, the descriptions and requirements given in the following are valid for both of them. In the following, we will use the wording "Broadcaster" for both the LB and RB.

To guarantee the availability of the EPN real-time data and products at the regional level, three RBs are in operation. Each RB makes available the data of all EPN stations as well as the EPN real-time products.

Useful details about real-time data streaming, processing and products can also be found in the "Guidelines for IGS Real-Time Broadcasters and Stations", accepted by the IGS GB in December 2021.

5.1 Broadcaster Sourcetable

Within the EPN the "Networked Transport of RTCM via Internet Protocol" (Ntrip) is used. Since 2007, Ntrip is a recommended DGNSS standard of Special Committee 104 of the "Radio Technical Commission for Maritime services" (RTCM). Current version Ntrip 2.0 is described in RTCM Paper 111-2009-SC104-STD (see https://www.rtcm.org, not freely available).

The Ntrip broadcaster receives streams from the stations or from other sources and disseminates them to clients on request. Clients may be users, data centres, analysis centres or monitoring tools. The broadcaster does not change the content of the streams. The broadcaster maintains a so-called sourcetable containing meta data. The sourcetable is made available on request, e.g. using an HTTP command.

A complete description of the content of a sourcetable, especially the three different record types can be found on http://software.rtcm-ntrip.org/wiki/Sourcetable.

In general, a Ntrip sourcetable consists of three types of records which are listed in Table 1. All three record types may appear more than once in a sourcetable. However, special sourcetables with e.g. caster records only are possible and valid. Caster and network record CAS and NET are not necessary to build a valid sourcetable. However,

5.1.1 An EPN sourcetable (RBs and LBs) should contain all three record types CAS, NET, and STR.

Each data field is separated by a semicolon: ";". In principle, some data fields could be left empty (i.e., two semicolons behind each other). However,

5.1.2 For the EPN broadcasters none of the data fields of each record type CAS, NET, and STR should be left empty.

CAS	*Caster specification record(s)*	*11 mandatory + 1 optional data fields*
NET	*Network specification record(s)*	*8 mandatory + 1 optional data fields*
STR	*Stream specification record(s)*	*18 mandatory + 1 optional data fields*

Table 1: Record Types of an Ntrip broadcaster sourcetable

Within each of the record types, one optional data field is allowed following the mandatory data fields.

Record Type CAS

The record type CAS is the caster specification record. It comprises 11 mandatory and one optional data field which can contain miscellaneous information as plain text.

5.1.3 At a minimum, the caster itself must be described in the sourcetable with a record type CAS.

5.1.4 EPN RBs should as a minimum list the CAS records for all RBs. Moreover, it is recommended to list the LBs from which they are pulling data. The RBs are responsible to keep the information consistent between the casters.

5.1.5 In data field #2 (<host>) it is recommended to use the domain name rather than the internet address (IP) of a caster.

Examples from the EPN RBs:

```
CAS;192.106.234.17;2101;NTRIPcaster/2.0.21;ASI - eGeos;0;ITA;40.65;16.07;0.0.0.0;0;http://euref-
ip.asi.it
CAS;www.euref-ip.net;2101;EUREF-IP;BKG;0;DEU;50.12;8.69;0.0.0.0;0;http://www.euref-ip.net/home
CAS;www.euref-ip.be;2101;ROBcaster;ROB;0;BEL;50.48;4.21;0.0.0.0;0;http://www.gnss.be
CAS;rtcm-ntrip.org;2101;NtripInfoCaster;BKG;0;DEU;50.12;8.69;http://www.rtcm-ntrip.org/home
```

5.1.6 It is recommended to add the caster 'rtcm-ntrip.org' to all EPN broadcasters because it contains caster information for a huge number of global, regional and local broadcasters.

Record Type NET

The record type NET is the network specification record. It comprises 8 mandatory and one optional data field which can contain miscellaneous information as plain text. Network records are used to group data sources according to their type or data provider or other useful specifications. Record parameter #6 to #8 contain useful information with web or mail addresses concerning the network or are even necessary for creating RINEX data from real-time data streams.

5.1.7 For EPN RBs it is mandatory that record parameter #7 <web-str> of the NET record points to a valid directory containing the RINEX skeleton files of the EPN stations (SKL files, see ftp://epncb.oma.be/pub/station/skl/).

NET records are not mandatory from the format description point of view. However,

5.1.8 For the EPN RBs it is mandatory to list NET records for all networks (record parameter #2 <identifier>) which are used in record parameter #8 <network> of the STR records used in the sourcetable. The RBs are responsible to keep the information consistent between the casters.

Example:

The NET record for network 'EUREF' on the three EPN RBs may look like this:

```
NET;EUREF;EUREF;B;N;http://www.epncb.oma.be/euref_IP;http://www.epncb.oma.be:80/stations/
log/skl;admin.name@e-geos.it;none
NET;EUREF;EUREF;B;N;http://www.epncb.oma.be/euref_IP;http://www.epncb.oma.be/stations/log
/skl;http://register.rtcm-ntrip.org;none
NET;EUREF;EUREF;B;N;http://www.epncb.oma.be/euref_IP;http://www.epncb.oma.be:80/stations/
log/skl;http://igs.bkg.bund.de/index_ntrip_reg.htm;none
```

Record Type STR

The record type STR is the stream specification record. It comprises 18 mandatory and one optional data field which can contain miscellaneous information as plain text. Although the <mountpoint> data field could contain almost any series of characters, for the EPN RBs short and unique mountpoint names should be envisaged which strongly rely on the station abbreviation used in the EPN.

5.1.9 The datastream mountpoint names of the EPN RBs should be restricted to ten characters. The first four characters are identical to the EPN 4-char site name, followed by two integer numbers, the 3-char country code plus one integer number. In general, the integer numbering should start with '0' (mandatory for new EPN stations).

5.1.10 Existing datastream mountpoints of an EPN station should be available at all EPN RBs.

5.1.11 The recommended format for a datastream (STR record data field #4 (<format>)) is defined in the *"Guidelines for EPN Stations and Operational Centres"* at *https://epncb.oma.be/_documentation/guidelines/guidelines_station_operationalcentre.pdf*.

5.1.12 The datastream mountpoint name for one EPN station should be identical at all EPN RBs. An identical mountpoint name at different broadcasters must be assumed to refer to the same real-time data.

5.1.13 The STR data field #5 (record parameter <format-details>) must reflect exactly the RTCM message types and update periods of the stream. This information must be consistent between the broadcasters.

There are two ways a data stream could be received at a broadcaster:

- uploading it to the broadcaster, e.g. by an Ntrip Server or any other software,
- pulling it, e.g. from another broadcaster or from a receiver.

This information is available, e.g. for the administrator, in the "sources" page of the broadcaster.

5.1.14 All streams provided in the frame of EUREF for EPN stations must refer to the network 'EUREF' (STR data field #8 <network>). EUREF streams proposed EPN stations should refer to a NET record 'PROPOSED'.

5.1.15 STR data fields #10 <latitude> and #11 <longitude> should be consistent with (e.g. extracted from) the EPN site log information.

Data field #14 <generator> of the STR record allows naming of the hard- or software generating the data stream. For observational data this could be for example a GNSS receiver or a network software. For product data stream this could be the software used for processing.

5.1.16 STR data field #14 <generator> for a real-time observation data stream should contain the name and type of the GNSS receiver used to create this data stream using the IGS naming conventions and in full agreement with the EPN site log information.

5.1.17 Within the EPN, the miscellaneous data field in the STR record should be used for the identification of the source of a data stream and the method coming to the respective broadcaster. If a real-time data stream is pulled from another broadcaster this must be reflected in the STR record data field#19 (<misc>). The information must contain the name or IP of the broadcaster (CAS record data fields #2 and #3), the original mountpoint name and the number of pullings in brackets. If a real-time data stream is actively streamed to a broadcaster the STR record data field#19 (<misc>) should contain the name of the organisation uploading the stream using the 3-char code used for the EPN Operational Center forms (see https://epncb.oma.be/ftp/center/oper/).

Example:

RTCM 3.1 data of EPN station USAL is uploaded from the OC ASI directly to the ASI RB. Hence, for ASI RB the string record will look like:

```
ASI
STR;USAL00ITA0;Lecce;RTCM
3.3;1006(60),1008(60),1013(60),1019,1020,1033(60),1042,1045,1077(1),1087(1),1097
(1),1127(1),1230(60);2;GPS+GLO+GAL+BDS;ASI;ITA;40.33;18.11;0;0;LEICA
GR30;none;B;N;10400;ASI
```

The BKG broadcaster is pulling USAL data stream from the ASI RB which gives for the BKG RB

```
STR;USAL00ITA0;Lecce;RTCM
3.3;1006(60),1008(60),1013(60),1019,1020,1033(60),1042,1045,1077(1),1087(1),1097
(1),1127(1),1230(60);2;GPS+GLO+GAL+BDS;EUREF;ITA;40.33;18.11;0;0;LEICA
GR30;none;B;N;10400;euref-ip.asi.it:2101/USAL00ITA0(1)
```

If ROB broadcaster was pulling it from the BKG RB, the STR record for ROB RB will look like

```
STR;USAL00ITA0;Lecce;RTCM
3.3;1006(60),1008(60),1013(60),1019,1020,1033(60),1042,1045,1077(1),1087(1),1097
(1),1127(1),1230(60);2;GPS+GLO+GAL+BDS;EUREF;ITA;40.33;18.11;0;0;LEICA
GR30;none;B;N;10400;www.euref-ip.net:2101/USAL00ITA0(2)
```

The real-time products of the IGS and EPN are delivered in the State Space Representation (SSR). More specifically, the IGS and EPN products are disseminated either in the IGS SSR format (see https://files.igs.org/pub/data/format/igs_ssr_v1.pdf) or in RTCM SSR format. The messages include multi-GNSS corrections for orbits, clocks, DCBs, phase-biases and ionospheric delays. For the details on the format refer to https://igs.org/rts/formats/. Currently, the EUREF-related corrections are simply derived by a transformation from the IGS combined correction stream. Examples:

```
STR;SSRA02IGS0_EUREF;RTCM-SSR APC ETRS89;RTCM
3.1;1057(60),1058(10),1063(60),1064(10),1240(60),1241(10);0;GPS+GLO+GAL;MISC;DEU
;50.00;10.00;0;1;BNC;none;B;N;800;EUREF filter combination
```

```
STR;SSRA02IGS1_EUREF;IGS-SSR APC ETRS89;RTCM
3.1;4076_021(60),4076_022(10),4076_041(60),4076_042(10),4076_061(60),4076_062(10
);0;GPS+GLO+GAL;MISC;DEU;50.00;10.00;0;1;BNC;none;B;N;800;EUREF filter
combination
```

6 Acknowledgement

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Maintenance of this document is managed by the EPN Network Coordinator at the EPN Central Bureau.
Please direct comments, questions, and suggestions to epncb@oma.be.